What is claimed is:

1. A method for manufacturing a shallow trench isolation (STI) in a semiconductor device, the method comprising the steps of:

a) preparing a semiconductor substrate obtained by a predetermined process on which a pad oxide and a pad nitride are formed on predetermined locations thereof;

b) forming a trench structure in the semiconductor substrate;

c) forming a hydrogen (H_2)-based high density plasma (HDP) oxide layer over a first resultant structure;

d) forming a nitrogen trifluoride (NF_3)-based HDP oxide layer into the trench structure with a predetermined depth;

e) carrying out a two-stage thermal process for removing fluorine in the NF_3-based HDP oxide layer; and

f) forming a helium (He)-based HDP oxide layer over a second resultant structure.

2. The method as recited in claim 1, wherein the step e) includes the steps of:

e1) carrying out a first-stage thermal process in an H_2O ambient furnace; and

e2) carrying out a second-stage thermal process in a nitrogen (N_2) gas ambient furnace.

3. The method as recited in claim 2, wherein the step

e1) and the step e2) are carried out by using a diffusion furnace.

4. The method as recited in claim 3, wherein the step e1) and the step e2) are carried out for about 30 minutes to about 10 hours at a temperature ranging from about 700 ℃ to about 1,100 ℃.

5. The method as recited in claim 1, wherein the step b) includes the steps of:

b1) patterning the semiconductor substrate by using the pad nitride as a mask;

b2) forming a liner nitride on a bottom and sidewalls of the trench structure and portions of the semiconductor substrate; and

b3) forming a liner oxide on the nitride layer.

6 The method as recited in claim 1, wherein the step c) is carried out by using a source gas having a silane (SiH_4) gas, an oxygen gas (O_2), a helium gas and an H_2 gas, wherein the flow rates of the SiH_4 gas, the O_2 gas, the He gas and the H_2 gas are in the range of about 40 sccm to about 50 sccm, of about 50 sccm to about 60 sccm, of about 400 sccm to about 600 sccm and of about 50 sccm to about 150 sccm, respectively.

7. The method as recited in claim 6, wherein the step c) is carried out on conditions that a low frequency (LF) power

is supplied in the range of about 3,000 W to about 3,500 W and a high frequency (HF) power is supplied in the range of about 400 W to about 600 W.

8. The method as recited in claim 1, wherein the step d) is carried out by using a source gas having the SiH_4 gas, the O_2 gas, the He gas and the NF_3 gas, wherein the flow rates of the SiH_4 gas, the O_2 gas, the He gas and the NF_3 gas are in the range of about 50 sccm to about 70 sccm, of about 100 sccm to about 150 sccm, of about 40 sccm to about 60 sccm and of about 20 sccm to about 80 sccm, respectively.

9. The method as recited in claim 8, wherein the step d) is carried out on conditions that the LF power is supplied in the range of about 4,000 W to about 6,000 W and the HF power is supplied in the range of about 900 W to about 1,000 W.

10. The method as recited in claim 1, wherein a top face of the NF_3-based HDP oxide layer is lower than the top face of the trench structure.

11. The method as recited in claim 1, wherein the step f) is carried out by using a source gas having the SiH_4 gas, the O_2 gas and the He gas, wherein the flow rates of the SiH_4 gas, the O_2 gas and the He gas are in the range of about 150 sccm to about 250 sccm, of about 300 sccm to about 400 sccm and of about 400 sccm to about 600 sccm, respectively.

12. A method for manufacturing an STI in a semiconductor device, the method comprising the steps of:

a) preparing a semiconductor substrate obtained by a predetermined process on which a pad oxide and a pad nitride are formed on predetermined locations thereof;

b) forming a trench structure in the semiconductor substrate;

c) forming an H_2-based HDP oxide layer over a first resultant structure;

d) forming an NF_3-based HDP oxide layer into the trench structure with a predetermined depth;

e) forming a He-based HDP oxide layer over a second resultant structure; and

f) carrying out a two-stage thermal process for removing fluorine in the NF_3-based HDP oxide layer.

13. The method as recited in claim 12, wherein the step f) includes the steps of:

f1) carrying out a first-stage thermal process in an H_2O ambient furnace; and

f2) carrying out a second-stage thermal process in an N_2 gas ambient furnace.

14. The method as recited in claim 13, wherein the step f1) and the step f2) are carried out by using a diffusion furnace.

15. The method as recited in claim 14, wherein the step f1) and the step f2) are carried out for about 30 minutes to about 10 hours at a temperature ranging from about 700 ℃ to about 1,100 ℃.

16. The method as recited in claim 12, wherein the step b) includes the steps of:

b1) patterning the semiconductor substrate by using the pad nitride as a mask;

b2) forming a liner nitride on a bottom and sidewalls of the trench structure and portions of the semiconductor substrate; and

b3) forming a liner oxide on the nitride layer.

17 The method as recited in claim 12, wherein the step c) is carried out by using a source gas having an SiH_4 gas, an O_2 gas an He gas and an H_2 gas, wherein the flow rates of the SiH_4 gas, the O_2 gas, the He gas and the H_2 gas are in the range of about 40 sccm to about 50 sccm, of about 50 sccm to about 60 sccm, of about 400 sccm to about 600 sccm and of about 50 sccm to about 150 sccm, respectively.

18. The method as recited in claim 17, wherein the step c) is carried out on conditions that a low frequency (LF) power is supplied in the range of about 3,000 W to about 3,500 W and a high frequency (HF) power is supplied in the range of about 400 W to about 600 W.

19. The method as recited in claim 12, wherein the step d) is carried out by using a source gas having the SiH_4 gas, the O_2 gas, the He gas and the NF_3 gas, wherein the flow rates of the SiH_4 gas, the O_2 gas, the He gas and the NF_3 gas are in the range of about 50 sccm to about 70 sccm, of about 100 sccm to about 150 sccm, of about 40 sccm to about 60 sccm and of about 20 sccm to about 80 sccm, respectively.

20. The method as recited in claim 19, wherein the step d) is carried out on conditions that the LF power is supplied in the range of about 4,000 W to about 6,000 W and the HF power is supplied in the range of about 900 W to about 1,000 W.

21. The method as recited in claim 12, wherein a top face of the NF_3-based HDP oxide layer is lower than the top face of the trench structure.

22. The method as recited in claim 12, wherein the step e) is carried out by using a source gas having the SiH_4 gas, the O_2 gas and the He gas, wherein the flow rates of the SiH_4 gas, the O_2 gas and the He gas are in the range of about 150 sccm to about 250 sccm, of about 300 sccm to about 400 sccm and of about 400 sccm to about 600 sccm, respectively.